EVM User's Guide: TRF1305A2-D2D-EVM, TRF1305B2-D2D-EVM, TRF1305C2-D2D-EVM

TRF1305x2-D2D Evaluation Module

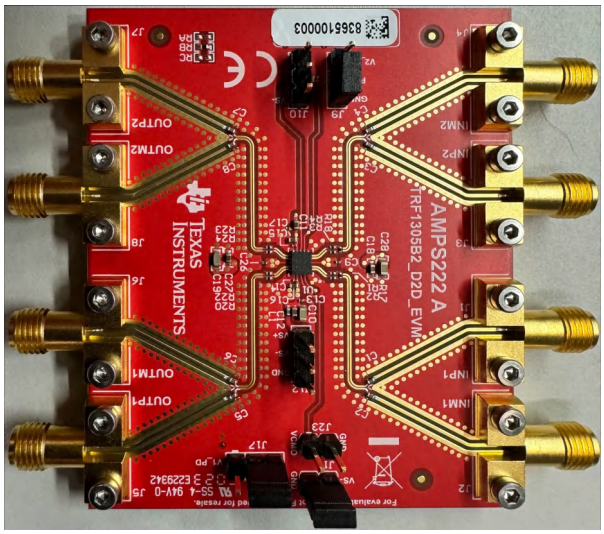
Description

The TRF1305EVM is designed to provide a quick setup to evaluate the TRF1305 series of fixed gain fully differential amplifiers (FDA) that have high linearity and 3dB bandwidth of the order of 6.5GHz. The TRF1305 are available in both single-channel and dual-channel packaging with three different fixed gains in each packaging. These amplifiers work with two flexible supply rails and can be dc-coupled and support a wide range of common-mode voltage.

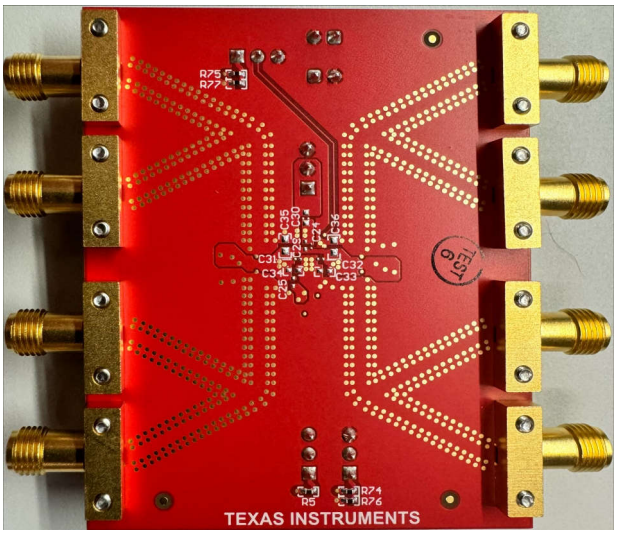
There are four types of EVMs that cover all device variants in the configurations.

Features

- Configured for split-supply operation and easily modified for single supply
- Single-ended or differential input signals
- Designed for easy connection to standard 50Ω input and output impedance test equipment
- Power down option available onboard using a jumper connector



TRF1305X2-D2D-EVM Board (Top View)



TRF1305X2-D2D-EVM Board (Bottom View)

1 Evaluation Module Overview

1.1 Introduction

This document is the user's guide for the evaluation boards (EVMs) meant for testing dual channel TRF1305 series of amplifiers in D2D configuration. There are four types of TRF1305 EVMs that are meant to test all device variants in different I/O configuration as shown in Table 1-1 below.

Table 1-1. TRF1305 EVMs

EVM	Devices	I/O Configurations	Comment
TRF1305x2-D2D	TRF1305A2 TRF1305B2 TRF1305C2	D2D, S2D[1]	Dual-channel amplifier - D2D (differential in, differential out) EVM.
TRF1305x1-D2D	TRF1305A1 TRF1305B1 TRF1305C1	D2D, S2D	Single-channel amplifier - D2D (differential in, differential out) EVM.
TRF1305x2-S2D	TRF1305A2 TRF1305B2 TRF1305C2	S2D	Dual-channel amplifier - S2D (single-ended in, differential out) EVM.
TRF1305x1-S2D	TRF1305A1 TRF1305B1 TRF1305C1	S2D	Single-channel amplifier - S2D (differential in, differential out) EVM.

This document also includes schematic diagrams, a bill of materials (BOM), printed-circuit board (PCB) layouts, and test block diagrams. Throughout this document, the abbreviations *EVM, EVM* or the term *evaluation module* means any one of the four EVMs listed above. This user's guide describes the basic steps and functions that are required for the proper operation and quick setup of the -EVM. Many sections in this user's guide are common to all TRF1305EVMs.

1.2 Kit Contents

Table 1-2 lists the contents of the EVM kit. Contact the Texas Instruments Product Information Center nearest you if any components are missing. TI highly recommends that users check the TI website to verify that the latest versions of the related software is being used.

Table 1-2. Kit Contents

Item	Quantity
TRF1305X2-D2D-EVM	1

1.3 Specification

Connector	Parameter	Value
J1	RF Input INP1	Max 20dBm
J2	RF Input INM1	Max 20dBm
J3	RF Input INP2	Max 20dBm
J4	RF Input INM2	Max 20dBm
J5	RF Output OUTP1	
J6	RF Output OUTM1	
J7	RF Output OUTP2	
J8	RF Output OUTM2	

[1] D2D EVMs can be configured in S2D by using a 50ohm SMA terminator on one of the inputs. For the best performance, S2D EVM is recommended.

Connector	Parameter	Value
J9	PD2 Select	Short 1,2 (V_PD) to disable Ch2. Short 2,3 (GND) to enable Ch2
J10	Mode Select	Open (default) See section 7.4.1 in data sheet for input common mode range extension
J11	J11.1 VS- J11.2 GND	Open in split supply operation Short in single supply operation
J12	J12.1 VS+ J12.2 VS- J12.3 GND	VS+ ≤ 5V VS- ≥ -2.5V (VS+) + (VS-) = 5V
J17	PD1 Select	Short 1,2 (V_PD) to disable Ch1. Short 2,3 (GND) to enable Ch1
J23	J23.1 VCMO J23.2 GND	Open (default) Apply external voltage to set desired output common mode

1.4 Device Information

The TRF1305x2 is a very high performance, closed-loop, dual-channel RF amplifier that has an operational bandwidth from true-dc to > 6.5GHz. The device has excellent performance to drive high-speed, high-performance ADCs, such as the ADC12DJ5200RF and ADC32RF5x with a dc- or ac-coupled interface. The device is optimized for performance in the preset gain configuration. If a lower-than-preset gain is desired, then use external resistors. The TRF1305x2 features a VOCM pin that allows setting different output common-mode and input common-mode voltages (for example, for level-shifting or for most IQ down-converter ADC-interface applications that have differing dc common-mode voltages). The floating 2-rail split or single-supply option, and a MODE pin that allows extending the input common-mode range closer to the supplies. High channel-to-channel isolation allows the device to be used in a complex IQ transmit or receive signal chain without loss of signal integrity. The TRF1305x2 has a feature to power down each channel individually.

2 Hardware

2.1 General Usage Information

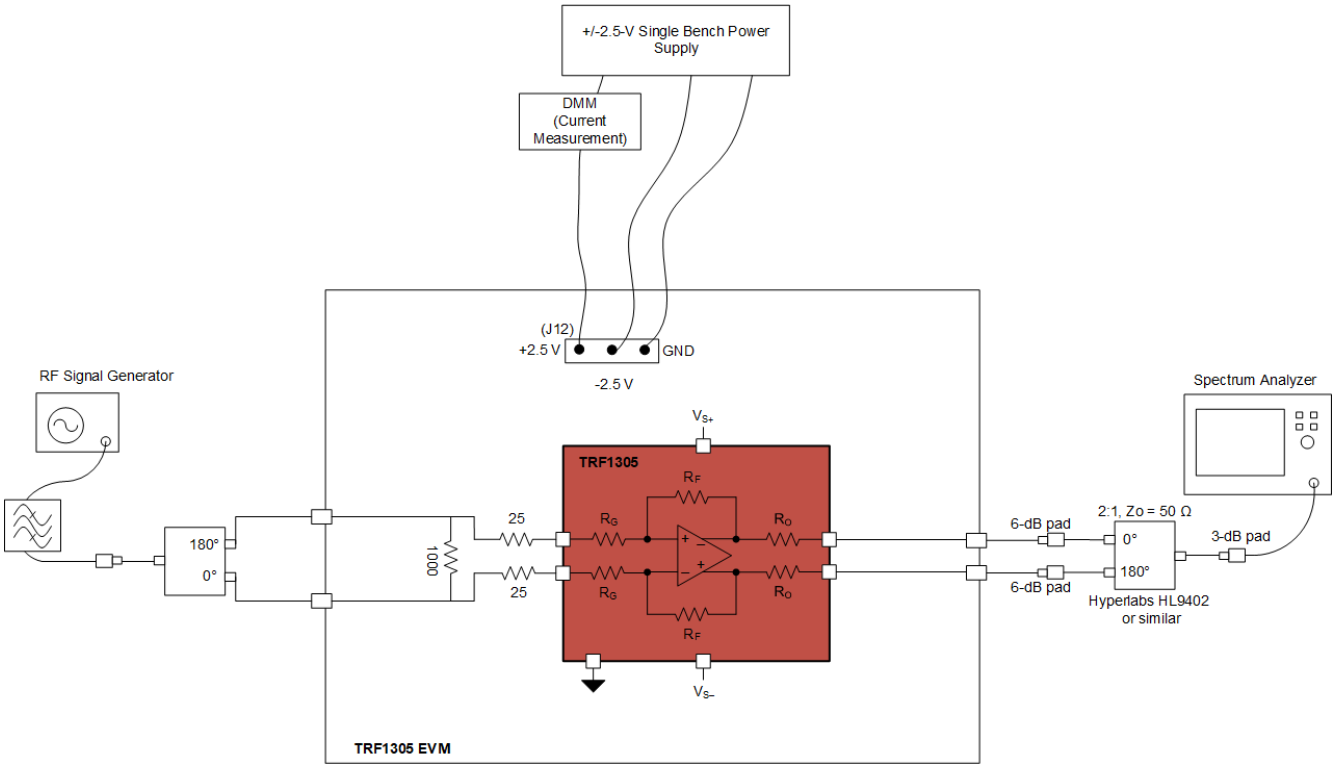


Figure 2-1. Single Tone Setup for Gain and Output P1dB

This section provides general usage information for the EVM. See Figure 2-1 for a general single tone setup diagram as a reference point for the following instructions (some components, such as supply bypass capacitors, are omitted for clarity):

1. Recommended power up sequence:
   - Split-supply operation:
     a. To operate as split supply, apply the positive supply voltage to VS+, negative supply voltage to VS– , and the ground reference from supply to GND (J12). The supply voltages do not need to be symmetrical, provided that the total supply voltage is 5V, any combination of positive and negative supply voltages is acceptable. This feature is often used when the output common mode voltage must be set to a particular value. For best performance, the power supply voltages must be symmetrical around the desired output common-mode voltage.
     b. Set the current limit of the DC output power supply at 250mA.
     c. Making sure the supply is turned off, connect the power supply cables to the J12 connector of the EVM.
     d. Now turn on the DC power supply of VS+ = 2.5V and VS- = -2.5V. The supply current (I_Q) drawn from the power supply is approximately 180mA.
     e. If the supply current is low, then verify that the device is not disabled by the PD pin (J17, J9).
   - Single-supply operation:
     a. To operate as single supply, connect jumper VS– to GND (J11), and apply the positive supply voltage to VS+ (J12). Inputs and outputs must be biased as in the TRF1305 data sheet specifications for proper operation.
2. Power-down option:
   - Connect +1.8V (logic-1) on PD pin to power-down the chip (J9, J17). Ground the PD pin to enable the chip.

3. CM (output common mode voltage) input:
   - The TRF1305 device has an output common-mode control pin that sets the output common mode voltage. The output common-mode voltage at the output pins, OUTPx and OUTMx, defaults to the LDO output voltage of VS– + 2.5V when VOCM pin is floated.
   - If a different output common-mode voltage is specified, then the J23 jumper can be used to connect an external low-impedance voltage source. See the TRF1305 data sheet for performance curves that show how performance is impacted by an output common mode voltage that is not at the mid-supply voltage.
4. Single tone measurement setup recommendation:
   a. Single ended signal from RF signal generator is converted to a differential signal using an external passive balun as shown in Figure 2-1. Differential signal is fed to input SMA connectors, J1, J2. When measuring single tone distortion, use an RF band pass filter as shown in Figure 2-1.
   b. The RF signal generator used must support up to 10GHz signal frequency for testing out the EVM.
   c. The device input is 50Ω in the pass-band. To minimize signal reflections due to impedance mismatch, TI recommends using an attenuator pad of approximately 3dB to 6dB between the source and J4 SMA input.
   d. The EVM outputs are fully differential (or 180° out-of-phase) at J5 and J6 SMA connectors. The device has low output impedance at dc and low frequencies.
   e. When connecting to a spectrum analyzer, the differential signal out of the EVM must be converted to a single-ended signal using an external passive balun as shown in Figure 2-1. Usage of an attenuator pad of approximately 3dB to 6dB is recommended at the three terminals of the passive balun to minimize reflections.
   f. Lastly, TI recommends to properly characterize and account for the insertion loss of RF coaxial (coax) cables, attenuator pads, and passive baluns to measure accurate gain and power levels for the device.

3 Hardware Design Files

3.1 Schematic

Figure 3-1 shows the EVM schematic.

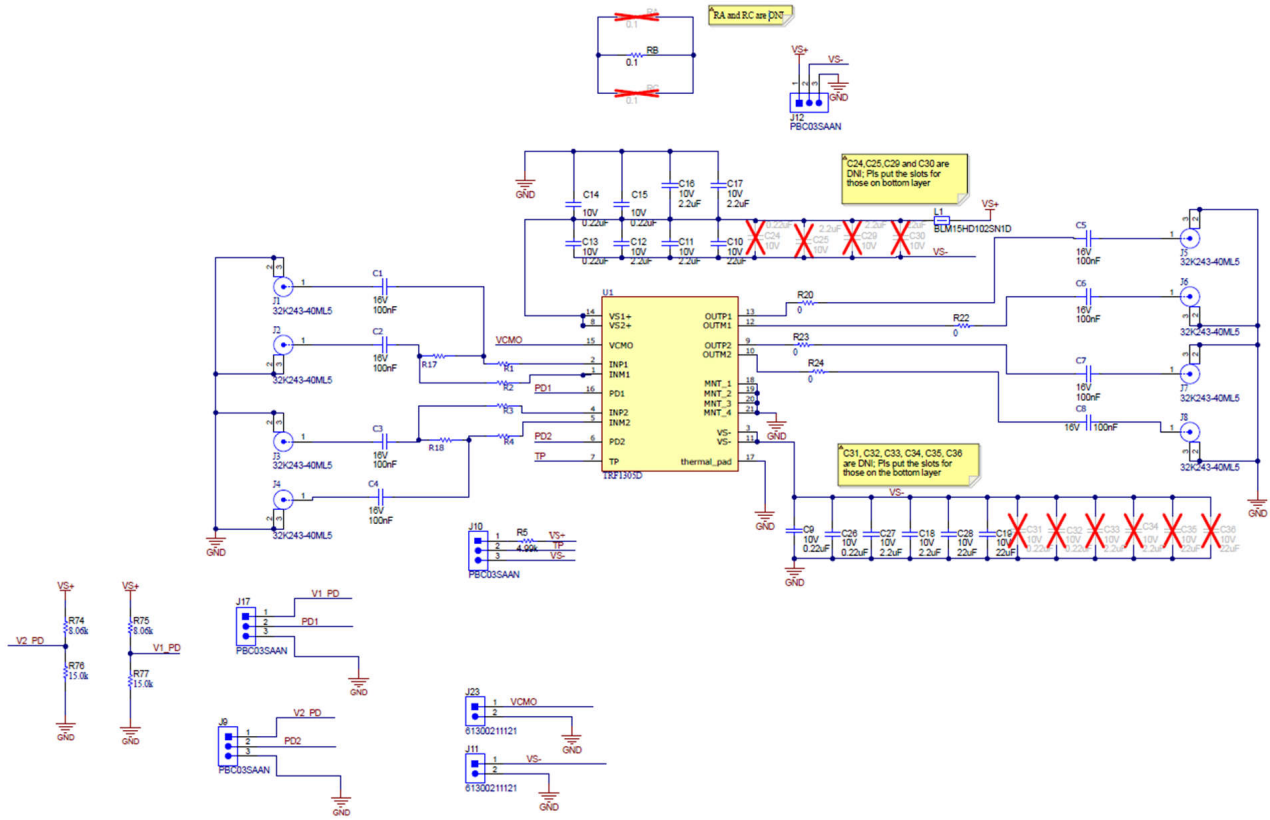


Figure 3-1. EVM Schematic

3.2 PCB Layout

Figure 3-2 through Figure 3-5 illustrate the PCB layers for this EVM.

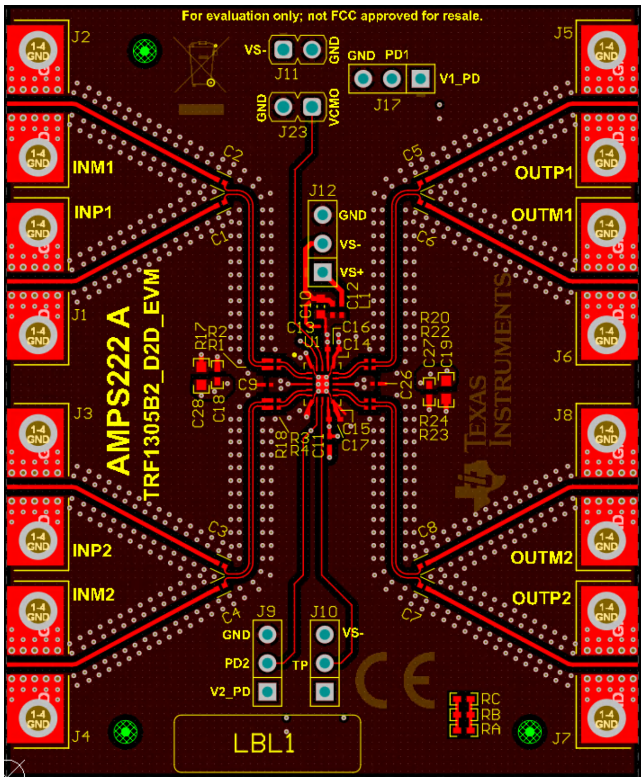


Figure 3-2. Top Layer

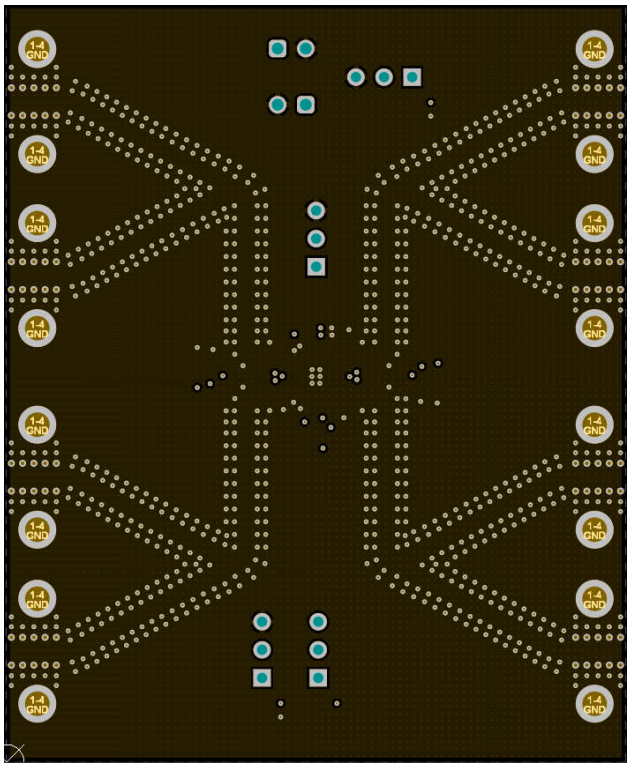


Figure 3-3. Layer 2

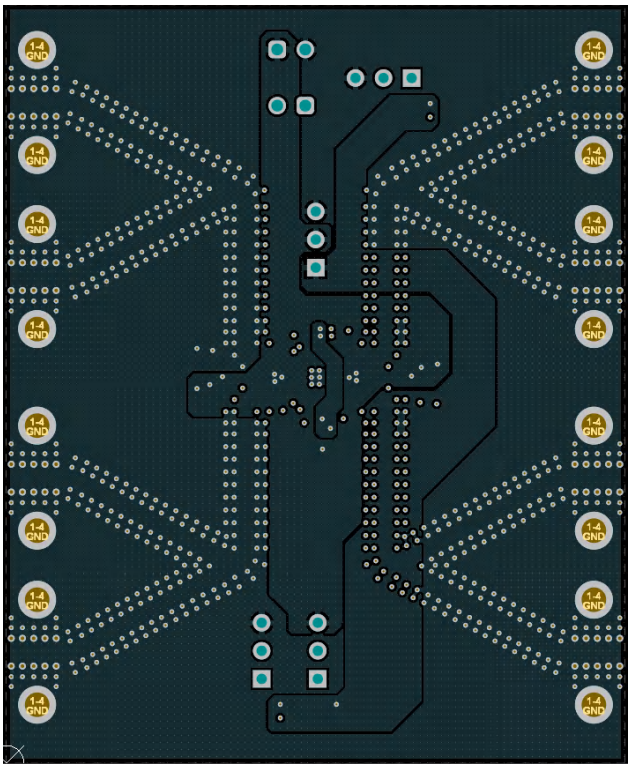


Figure 3-4. Layer 3

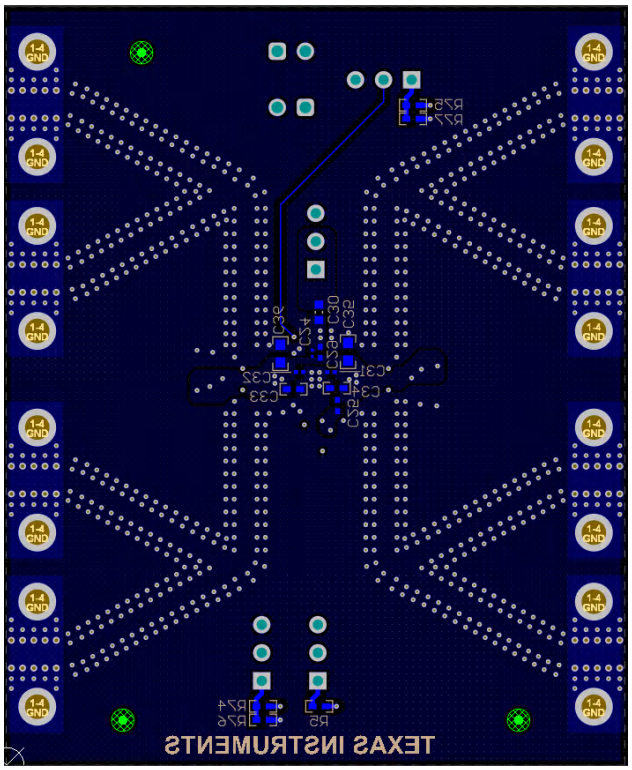
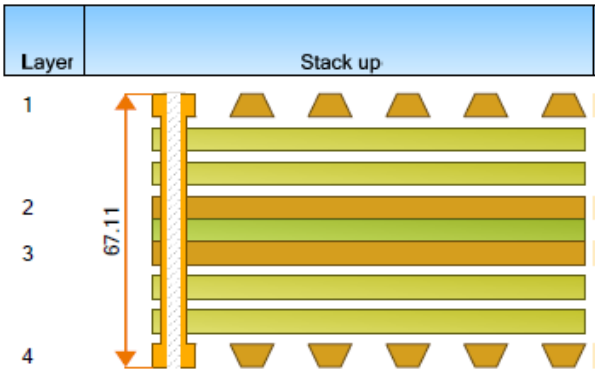


Figure 3-5. Bottom Layer

3.2.1 Stack-Up and Material

The EVM is a 67-mil, 4-layer board with material type Isola® 370HR. The top layer routes the power, ground, and signals between SMA connectors and the device. Second layer is the reference RF ground layer. The signal trace impedance is targeted at 50Ω. The bottom three layers are ground layers.



Layer	Stack up	Supplier	Supplier Description	Description	Base Thickness	Processed Thickness	εr
1		GOULD	COPPER FOIL	12+35 m	1.850	2.559	
		ISOLA	185HR	#2116	5.000	4.966	4.320
		ISOLA	185HR	#2116	5.000	4.966	4.320
2					1.378	1.378	
		ISOLA	185HR	1.00 1.0/1.0	39.370	39.370	4.420
3					1.378	1.378	
		ISOLA	185HR	#2116	5.000	4.966	4.320
		ISOLA	185HR	#2116	5.000	4.966	4.320
4		GOULD	COPPER FOIL	12+35 m	1.850	2.559	

Figure 3-6. EVM Stack-Up (Units in Mils)

3.3 EVM Bill of Material

Table 3-1. Bill of Materials

Item #	Designator	Quantity	Value	Description	Part Number	Manufacturer	Package Reference
1	!PCB	1		Printed Circuit Board	AMPS222	Any	
2	C1, C2, C3, C4, C5, C6, C7, C8	8	100nF	0.1µF ±10% 16V Ceramic Capacitor X7R 0402 (1005 Metric)	ATC530L104KT16T	American Technical Ceramics	0402
3	C9, C13, C14, C15, C26	5	0.22uF	CAP, CERM, 0.22uF, 10V, +/- 20%, X5R, 0201	LMK063BJ224MP-F	Taiyo Yuden	0201
4	C10, C19, C28	3	22uF	CAP, CERM, 22uF, 10V, +/- 20%, X5R, 0603	CL10A226MP8NUNE	Samsung Electro-Mechanics	0603
5	C11, C12, C16, C17, C18, C27	6	2.2uF	CAP, CERM, 2.2uF, 10V, +/- 10%, X7S, 0402	C1005X7S1A225K050BC	TDK	0402
6	J1, J2, J3, J4, J5, J6, J7, J8	8		SMA JACK 50 OHM, R/A, SMT	32K243-40ML5	Rosenberger	SMA JACK, R/A, SMT
7	J9, J10, J12, J17	4		Header, 100mil, 3x1, Gold, TH	PBC03SAAN	Sullins Connector Solutions	PBC03SAAN
8	J11, J23	2		Header, 2.54mm, 2x1, Gold, TH	61300211121	Wurth Elektronik	Header, 2.54mm, 2x1, TH
9	L1	1	1000 ohm	Ferrite Bead, 1000 ohm @ 100MHz, 0.25A, 0402	BLM15HD102SN1D	MuRata	0402
10	LBL1	1		Thermal Transfer Printable Labels, 0.650" W x 0.200" H - 10,000 per roll	THT-14-423-10	Brady	PCB Label 0.650 x 0.200 inch
11	R1, R2, R3, R4	4	24.9	24.9 Ohms ±1% 0.05W, 1/20W Chip Resistor 0201 (0603 Metric) Thick Film	ERJ-1GNF24R9C	Panasonic Electronic Components	0201
12	R5	1	4.99k	RES, 4.99 k, 1%, 0.063 W, 0402	RC0402FR-074K99L	Yageo America	0402
13	R17, R18	2	1k	1 kOhms ±1% 0.05W, 1/20W Chip Resistor 0201 (0603 Metric) Automotive AEC-Q200 Thick Film	ERJ-1GNF1001C	Panasonic Electronic Components	0201
14	R20, R22, R23, R24	4	0	RES, 0, 5%, .05 W, AEC-Q200 Grade 0, 0201	ERJ-1GN0R00C	Panasonic	0201
15	R74, R75	2	8.06k	RES, 8.06 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	CRCW04028K06FKED	Vishay-Dale	0402
16	R76, R77	2	15.0k	RES, 15.0 k, 1%, 0.063 W, 0402	CRCW040215K0FKED	Vishay-Dale	0402
17	RB	1	0.1	RES, 0.1, 1%, 0.25 W, 0402	ERJ2BWFR100X	Panasonic	0402

Table 3-1. Bill of Materials (continued)

Item #	Designator	Quantity	Value	Description	Part Number	Manufacturer	Package Reference
18	U1	1		TRF1305A2RYPR, TRF1305B2RYPR, TRF1305C2RYPR	TRF1305D	Texas Instruments	WQFN16
19	C24, C31, C32	0	0.22uF	CAP, CERM, 0.22uF, 10V, +/- 20%, X5R, 0201	LMK063BJ224MP-F	Taiyo Yuden	0201
20	C25, C29, C33, C34	0	2.2uF	CAP, CERM, 2.2uF, 10V, +/- 10%, X7S, 0402	C1005X7S1A225K050BC	TDK	0402
21	C30, C35, C36	0	22uF	CAP, CERM, 22uF, 10V, +/- 20%, X5R, 0603	CL10A226MP8NUNE	Samsung Electro-Mechanics	0603
22	FID1, FID2, FID3, FID4, FID5, FID6	0		Fiducial mark. There is nothing to buy or mount.	N/A	N/A	N/A
23	RA, RC	0	0.1	RES, 0.1, 1%, 0.25 W, 0402	ERJ2BWFR100X	Panasonic	0402

4 Additional Information

4.1 Trademarks

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5 Related Documentation

For related documentation, see the following:

- Texas Instruments, *TRF1305B2 Dual-Channel, DC to > 6.5GHz 3dB BW, Fully Differential Amplifier* data sheet

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